ROGER BACON

ON THE NULLITY OF MAGIC

B / 31

ROGER BACON'S LETTER

Concerning the Marvelous Power of Art and of Nature and Concerning the Nullity of Magic

Translated from the Latin

by

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Together with notes and an account of Bacon's life and work

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PREFACE

The present volume makes accessible to English readers an important classic in the history of science, the work of one of the greatest Englishmen who ever lived. Perhaps no further apology is needed for its presentation. Yet the general reader will find in it much which intrigues the interest and stimulates the imagination. The present translation was undertaken without knowledge of the existence of the English translation of 1659; the finding of the earlier translation deprived the undertaking of much of its original interest, but it has been completed in the hope that other students of the history of thinking may be glad to have the work in an accessible form.

It is believed that the discursive notes perhaps contribute something to the value of the present translation. For the material in the introductory essay on the life and works of Roger Bacon, I am indebted in large part to the "Roger Bacon Commemoration Essays," edited by Little (Oxford, 1914)—and to that work the reader is referred for many details which could not properly be discussed in that short essay.

Would that someone with more skill and more leisure than I might give us an English translation of *Opus Majus*.

T. L. D.

Cambridge, Massachusetts.

FRIAR BACON

ROGER BACON'S LIFE AND WORK

Aristotle believed the intelligence to reside in the stomach. Yet there were men in his time less wise than he who held the opinion that it resided in the brain. Aristotle examined all men's opinions, but studied the organs for himself, and reached his own opinion that the brain is an organ for cooling the blood—how his own must have ached from his studies—and the stomach is the seat of the intelligence, for reasons which may be summed up by the consideration that a man's readiness to think depends greatly upon the state of his digestion. This wrong opinion rightly held is a more creditable commentary on the soundness of Aristotle's genius than right opinions wrongly held could be. He was great enough to be guided by the evidence at hand.

The guess has been hazarded that the works of Aristotle, like those of Homer, were the production of a school, of a company of compilers, who worked under a corporation name. Josiah Royce was asked if he thought Aristotle was a syndicate, and answered "No, he was too great a man for that."

Roger Bacon lived in a period of intellectual darkness. Yet the tremendous breadth of his knowledge would make us suspect him of being a syndicate if we lacked the actual material of his biography. He believed that the disposition of the planets had its influence on the

destinies of men. He probably thought that the transmutation of base metals into gold was entirely possible. Accused of magic and suspected of dealings with the devil, he wrote a tract on the nullity of magic in which he pointed out that many things reputed to be magic are really due to the natural operations of Nature. In crediting Nature, he discredited the devil and narrowly escaped the fate of those who discredited God. He lived in a time when opinions of any kind, except those which were held by all, were dangerous.

Seven hundred years ago the best educated people were superstitious and believed in spirits, charms, magic, and incantations. Medicine was the art of pacifying evil demons. Bacon wrote wisely of inherited infirmities, of diet, exercise, etc., as a means of producing long life, of the sympathetic effects of malevolent and benevolent personalities. He knew that charms in medical practice have a psycho-therapeutic efficacy, and his remarks on the subject are not surpassed in scientific accuracy by modern writings on auto-suggestion.

Seven hundred years ago the Earth was supposed to be flat, and the Church insisted that it was the center of the Universe. Long before that, the Alexandrians had had a better understanding of the order of things. Bacon knew their evidence and agreed with their opinion that the Earth is round. He believed its radius to be 3,245 miles and calculated its circumference on the assumption that the circumference is three and one-seventh

times the diameter. In his *Opus Majus* he asserted the possibility of voyaging westward from Spain to India in a passage which was inserted, without acknowledgment of source, by Cardinal Pierre d'Ailly (died 1425) in his *Imago Mundi,* first printed at Louvain in 1480. The passage so impressed Columbus that he annotated it fully and quoted it in a letter to Ferdinand and Isabella—and Bacon at second hand became one of the causes which led to the discovery of America.

Bacon was familiar with Hebrew, Greek, Chaldaic, and Arabic—and with the knowledge which had been written in these languages. This knowledge he treated critically and wrote down anew in a time when the large part of it had been forgotten or was held in disrepute. In the tract which is translated in the present volume he speaks of the pulley and of lenses, two centuries before they are generally supposed to have been invented by the investigators of the Renaissance. He speaks of self-propelled vehicles, of under-water craft, and of the flying machine. All of these he has actually seen himself except the flying machine—and he is sure that that is possible for he knows a clever thinker who has thought it out. Gunpowder he describes, probably having learned of it from the Arabians. And to him at any rate belongs the credit for bringing it to the attention of Europe and of the later inventors who applied it to firearms for war and to mining for the purposes of peace. It has brought on the age of metals, and has

given us, as Bacon promised, the "key which opens and no man shuts; and when he will shut, no man opens."

Bacon lived at a time when ignorance was at a premium. Saint Augustine had written, "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all powers of the human mind." Ignorance, therefore, was piety. Inquiry was sacrilege. And so great was the force of this opinion that people were still burned at the stake or otherwise horribly tortured, several centuries after Bacon's time, for venturing to accept the authority of sound reasoning and of their own experience and observation. Living when he did, it is not to be wondered at that Bacon was occasionally mistaken: the marvel is rather that he was so commonly clear-headed and so generally right. To his immortal credit is his insistence that without experience nothing can be known with certainty.

Bacon did not invent the inductive method. He insisted on basis of experience and on verification by experiment, at a time when official access to knowledge was solely by argument. In the *Opus Majus* he writes, "There are two methods by which we acquire knowledge, by argument and by experiment. Argument shuts up the question, and makes us shut it up too; but it gives no proof, nor does it remove doubt and cause the mind to rest in the conscious possession of truth, unless the truth is discovered by way of experience. For example, if any man who had never seen fire were to prove by

satisfactory argument that fire burns and destroys things, the hearer's mind would not rest satisfied nor would he avoid fire, until by putting his hand or some combustible thing into it, he proved by actual experiment what the argument laid down. But after the experiment has been made, his mind receives certainty and rests in the possession of truth, which could not be given by argument but only by experience. And this is the case even in mathematics where there is the strongest demonstration."

"This Science (of experiment) has three great prerogatives in respect to all the other sciences. The first is—that it investigates their conclusions by experience. For the principles of the other sciences may be known by experience, but the conclusions are drawn from these principles by way of argument. If they require particular and complete knowledge of these conclusions, the aid of this science must be called in. It is true that mathematics possesses useful experience with regard to its own problems of figure and number, which apply to all the sciences and to experience itself, for no science can be known without mathematics. But if we wish to have complete and thoroughly verified knowledge, we must proceed by the methods of experimental science." The other two prerogatives of experimental science, according to Bacon, are these, that it gives access to a knowledge of truth which cannot be reached by the special sciences, and that by using and combining the results of the other sciences it is able to investigate in-

accessible things, to predict future events, and to devise powerful instruments and machines. The practice which Bacon urged seven centuries ago, the practice of investigating conclusions by experience, has been exalted in recent philosophical discussion under the new name of "Pragmatism."

Roger Bacon was born about 1214 near Ilchester in the county of Somerset, England. Concerning his early life but little is known. He had an elder brother ("my rich brother") who succeeded to the estates, but who, supporting the king's cause during the Baron's War, was driven out with his relatives and reduced to poverty. He had another brother whom he described as a "scholar." Bacon went to Oxford—in his time boys usually went there at the age of twelve or thirteen years—and was awarded the Master or Arts degree at an unknown date. There is no evidence that he had the degree of Doctor of Divinity or of Medicine. The title of *doctor mirabilis*, applied to him during the centuries which have intervened, seems to have meant that he was a marvelous teacher.

He acquired fame by his lectures at Oxford and at Paris, and wrote many elementary treatises for students. Before he joined the Franciscan Order he had cut loose from the traditional lines of study and had shown no hesitation in criticizing conventional beliefs or the opinions of those high in authority. His reasons for joining the Franciscans are not known to us, nor is the date

at which he took the step. "Men used to wonder," he writes, "before I became a friar (*in alio statu*) that I lived owing to my excessive labors." In 1267 he tells, "During the twenty years in which I have labored specially in the study of wisdom, after abandoning the usual methods, I have spent more than 2,000 *l.* on secret books and various experiments, and languages, and instruments, and mathematical tables, etc." Although the Parisian pound was equal only to a third of a pound sterling, the sum is considerably larger than a mendicant friar could have gathered together, and we may infer that Bacon had funds of his own before he joined the order.

Bacon probably went to Paris before 1236, for he reports that he commenced his work *De Accidentibus Senectutis* at the suggestion of two wise men one of whom he names as Philip, Chancellor of Paris—and Philip de Grève who occupied that position died in 1236. He reports that he saw at Paris with his own eyes Alexander of Hales (died 1245), twice heard William of Auvergne dispute on the *Intellectus Agens* before the whole university, and heard Master John de Garlandia denounce ignorant etymologists. It was probably after coming to Paris that Bacon joined the Franciscans; he was then of mature years, had begun to lecture and think independently, and may perhaps have felt need for the protection of a powerful organization.

His health broke down and for ten years (1256-1266) "owing to many infirmities" he was obliged to withdraw

from all public part in university affairs. During this time he instructed boys in mathematics, sciences, and languages, and seems to have been in the habit of supplying new masters of arts at their inception or inaugural dissertation with problems in geometry which none of their hearers could solve. He mainly occupied himself with experimentation in physics, especially in optics, with the making of lenses and the construction of astronomical tables, and with the elaboration of his theory of the propagation of force. He kept himself well informed on public and political affairs and used contemporary events to illustrate points in his arguments. He read books of travel and knew many important men. By his bitter tongue he made enemies, chief among whom perhaps was Albert the Great. This man perhaps thought of Bacon when he denounced those critics who were too idle to publish works of their own and who read the works of others only to find fault with them, for Bacon at this time admits that he had written very little of a systematic nature. He confined his writing largely to letters to friends who had asked his opinion on various matters, among these letters the one which is translated in the present volume. During this period however he probably wrote *De Speculis,* the long astronomical treatise *De Computo Naturali,* the *Metaphysica,* which remains to us only in fragmentary form and conveys an inadequate impression of Bacon's ability to deal with philosophical questions, and probably a version of the im-

portant physical work, *De Multiplicatione Specierum*, on the propagation of force.

Bacon's most important works were written because of the stimulus of a request by the Pope. Guy de Foulques, Archbishop of Narbonne (1259) and Cardinal-Bishop of St. Sabina (1261) had heard of the writings of Bacon and had commissioned one of his servants to obtain them. In the meantime he was elected Pope under the title of Clement IV on February 5, 1265. Bacon replied to him by letter in March, 1266, and his remarks so pleased the Pope that the Pope wrote to him the following June asking him to send copies of his works secretly and without delay notwithstanding any constitution of the Franciscan Order to the contrary. The request filled Bacon with gratitude. He replied, detailing the difficulties which he had encountered in his writing and concluded that nothing worthy of his Holiness had yet been written—the whole must be started again at the beginning. Commencing promptly on the ambitious project of a systematic and scientific treatment of the various branches of knowledge, he worked until January, 1267, writing parts of the *Communia Naturalium* and *Communia Mathematicae*, but found the task impossible. He started once more on a less pretentious scale and within a year had written the *Opus Majus* and *Opus Minus*, to which later the *Opus Tertium* was added. While there are doubts whether the last of these was ever sent to the Pope, the first two

were sent early in 1268 along with two versions of the treatise on the propagation of force and a separate treatise on alchemy. But, unfortunately for Bacon, Clement IV died in November, 1268, and his successors had less sympathy for Bacon's kind of intellectual activity.

The *Opus Minus* and *Opus Tertium* were summaries of the *Opus Majus* containing a further discussion of special points and certain additional material on alchemy and astrology. The *Opus Majus* Bacon regarded as a *Persuasio* or *Tractatus praeambulus*, in distinction from a comprehensive and systematic treatment of all the sciences which he hoped to write later, for its prime purpose was to persuade of the practical usefulness of wisdom. The first part deals with the causes which hindered the progress of true philosophy among the Latins, namely, dependence on authority, consent to established custom, allowing weight to popular opinion, and concealment of real ignorance with pretense of knowledge. It constituted a complete break with the spirit and method of scholasticism. The second part deals with the relation between Philosophy and Theology, a subject which does not seem to have interested Bacon very greatly, although theology was the principal interest of the Middle Ages. It contains the much-quoted sentence, "The end of all true philosophy is to arrive at a knowledge of the Creator through knowledge of the created world." In the third part Bacon begins to lay the foundations of his contentions. He insists on the im-

portance of the study of grammar, or, as we would call it, philology: in particular the Greek, Hebrew, Chaldaic, and Arabic languages ought to be mastered, for the Scriptures and best philosophical works are written in these tongues and are frequently misinterpreted in existing translations. In the fourth part of the *Opus Majus* Bacon deals with mathematics, a subject which he believed to be most fundamental, "the gate and key of the natural sciences," "the alphabet of philosophy." "Physicists," he says, "ought to know that their science is powerless unless they call in the aid of mathematics," an opinion, not put forward merely on its own merits, but defended by a broad and inclusive theory of natural action. Force is propagated or "multiplied" uniformly and regularly in space and time, and can be represented by lines and figures. Geometry is necessary in order to explain the action of natural forces, and all physical science is ultimately mathematical—an idea greatly in advance of those of any preceding thinker, the idea which operated in the minds of Stevinus and da Vinci and Galileo to produce the modern science of mechanics. Bacon wrote "in mathematics alone is certainty beyond all question," and thought so highly of the subject that he made logic entirely subordinate to it. With this opinion Bertrand Russell and other present logicians are in harmony, and a discussion of the matter would lead us to some of the most subtle distinctions of contemporary philosophy. The fifth part of the *Opus*

Majus deals at great length with optics, a subject eminently adapted to mathematical treatment. Bacon discusses vision in a straight line, the laws of reflection and refraction, the construction and properties of mirrors, lenses, and burning-glasses, but his knowledge of these matters does not seem to exceed that of earlier Arabian writers. The sixth part is the most important section of the *Opus Majus,* for it treats of experimental science, *domina omnium scientiarum et finis totius speculationis.* It shows strong opposition to current modes of thought and well-grounded objection to current procedure in the study of Nature, and a clear perception of the necessity for first-hand investigation; it contains an attempted classification of the sciences and foreshadows a new method of research. It is in many ways parallel to the presentation four centuries later in Francis Bacon's *De Augmentis* and *Novum Organum.* The seventh part deals with moral philosophy. It consists large of quotations from the dialogues of Seneca which Bacon had just discovered after a search of more than twenty years, it includes many pages from Bacon's Metaphysics, and is perhaps the least satisfactory portion of the work.

Shortly after the death of Clement IV Bacon evidently returned to Oxford where he wrote a commentary on the pseudo-Aristotelian *Secretum Secretorum,* a spurious work by which he seems to have been deeply interested (Compare his frequent reference to it in the letter of the present volume). About this time he wrote

also the Greek and Hebrew Grammars and the fragment which is generally known as *Compendium Studii Philosophiae*. The latter work deals with the value and essentials of knowledge and with the methods of acquiring it and the impediments in the way to doing so. It contains violent attacks on the papal court, on all religious orders without exception, on the clergy and universities, on kings and princes and lawyers. Bacon planned a large work which was to consist of four volumes treating of all of the principal branches of knowledge, but he seems to have had the habit of starting according to one plan and of changing his plans and starting anew. Only certain fragments of this large work were ever written.

By fearless expression of his opinions and by biting denunciation of all established authority, Bacon made many enemies both in his own Order and outside of it. Accused of magic and astrology, he was thrown into prison in 1277 and remained there until 1292 when he was released, it is supposed, through the intercession of Raymond Gaufredi. It is certain that his last dated work was written in 1292, a fragment called *Compendium Studii Theologiae* which treats again of the causes of error and of the danger of undue reliance on authority. The historian John Rous reports "The noble doctor Roger Bacon was buried at Grey Friars in Oxford, A. D. 1292, on the feast of St. Barnabas the Apostle" (June 11).

It is said that on his deathbed he made the bitter

complaint, "I repent of having given myself so much trouble to destroy ignorance." Later time has more highly valued his effort. A recent writer has set down Roger Bacon as one of the six greatest men of all history.

The Letter of Roger Bacon Concerning the Marvelous Power of Art and of Nature and Concerning the Nullity of Magic

I am responding to your request. Even if Nature is powerful and marvelous, yet Art using Nature for an instrument is more powerful by virtue of Nature, as we see in many instances. Indeed whatever is beyond the operation of Nature or of Art is not human or is a fiction and the doing of fraudulent persons.

Fictitious Appearances.—There are those who, by quickness of movement and by the appearance of the members, or by variations of the voice, or by the subtlety of instruments, or by shadows, or by playing upon popular opinion, propound to mortals many wonders which do not have the truth of existence. This world is full of such people as is manifest—for jugglers deceive many by quickness of hand, and ventriloquists, by a variety of sounds in the belly and throat, and by mouth, produce human voices, at a distance or nearby as they wish, as if a spirit were talking in the manner of a human being. They also imitate the sounds of animals. Truly, the spurious and counterfeit causes which are contrived with great deceit show that the force is human and not spiritual.[1] When inanimate things are moved rapidly in the shadow of dusk or of night, it is

not truth but is fraud and deceit. Verily, popular opinion does anything that men wish it to do so long as men are agreed about it.[2]

Invocation of Spirits.—In such cases as these physical Reason does not consider, and Art and the power of Nature are not taken into account. Beyond these there is a more wicked practice still, when men hold the laws of Philosophy in contempt and, contrary to all reason, invoke nefarious spirits in order that through them they may accomplish their desire. But there is error in this because men believe the spirits subject to them and believe that they are driven by the force of human will—which is impossible, because human forces are far inferior to spirit forces. They also err greatly when they believe themselves able, through such natural means as they use, to call forth or to drive away malign spirits; and they err also when they try to please them with invocations, prayers, and sacrifices and so to make them propitious to their design. Certainly it would be easier without comparison through the agency of God or of good spirits to accomplish anything that man ought to consider useful. And malign spirits do not assist in their useless purposes those whom they favor except in so far as, by reason of the sins of men, it is permitted by God who rules and directs the human race and to whom its ways are above documents of wisdom. Indeed they work better by contraries—and Philosophers never trouble themselves about these six modes. P. C2.

Symbols, Characters, and Magic Practices.—What beliefs ought to be held about magic symbols and characters and about similar things is the next matter for my consideration. For I doubt very much whether all things of this complexion are now false and dubious, for certain of these irrational inscriptions have been written by philosophers in their works about Nature and about Art for the purpose of hiding a secret from the unworthy, so that it should be as if it were wholly unknown—as that lodestone attracts iron, for instance — and someone wishing to achieve his work under the eyes of the multitude might make magic symbols and proffer characters with the intention of representing the force of attraction. Yet this may be an entirely erroneous interpretation. Therefore, while many things are hidden by many means in the books of the Philosophers, the wise man ought to be prudent in dealing with them, to the end that he may reject the magic symbols and characters and study the work of Nature and of Art. Thus animate and inanimate will be seen to concur with Nature, because of the Conformity of Nature, not because of the virtue of magic symbols and characters. And so, many secrets of Nature and of Art are esteemed magic by the untaught, and Mages stupidly seize upon symbols and characters because they ascribe a virtue to them, and, in the pursuit of them, relinquish the work of Nature and of Art because of the error of magic

symbols and characters. Each class of these men through its own stupidity deprives itself of the use of the others' wisdom.

Certain Cases Authorized by the Church.—There are however certain prayers instituted of old by men of truth, especially those ordained to God and to the angels, and others of that sort, which are able to retain their original virtue. Thus, in many regions it is still the practice to pronounce certain incantations over iron while it is glowing from the fire, and over the waters of a river, and similarly in other cases in which innocent persons are proved innocent and the guilty condemned for their act—and it is believed that these things are done by the authority of the prelates. For the priests themselves make exorcisms, as in the case of the Blessed Water with which adulteries are tested or the fidelity of a woman to her husband, as is prescribed in the ancient law *de Aqua purgatorii*. And there are many similar instances.

Books of the Magi.—But whatever is contained in the books of the Mages ought to be prohibited, for these books, though they may contain something of the truth, have so much falsity in them that it is impossible to distinguish between the true and the false. For this reason it ought to be denied, which is claimed by some, that Solomon and other wise men composed these books —for books of this sort are not received by the authority of the Church nor by wise men but only by seducers

who accept the naked letter and themselves compose new books and multiply inventions—as we know by experience—and inscribe renowned titles on their works and imprudently ascribe them to famous authors, so that men may be allured more powerfully by that means. And in order that no one shall suspect them, with allusions they build up a high-sounding style and construct their mendacity under the form of a text.

Magic Figures.—Magic figures are words the position of whose letters has been altered in such manner that they contain an adventitious meaning, or they are the figures formed by the position of the stars at certain chosen seasons. On characters of the first kind the same judgment ought to be passed as that which has been made above upon incantations; and, as for signs and characters of the second sort, unless they are made at the proper time, they are recognized as having no inward efficacy. And that man is judged by every wise person to be entirely futile who devises these things to be written in books and does it without consideration of anything except of the single figure which they exemplify.

Disposition of the Stars.—Moreover, men who carry out their affairs according to the face of the heavens and the disposition of the constellations are at liberty to ascribe not only these figures themselves but all of their works as well, directly, to the virtue of Art and of Nature as, less directly, to the virtue of the heavens. But

since it is difficult to perceive the certitude of the heavens, there is much error about these matters among many people—and there are few who know how to conduct the matter usefully and veraciously. Because of this the crowd of Mathematicians who judge and act according to magic stars accomplish but little, while those who are well-skilled and understand the art sufficiently may be able, at chosen times, to do many useful things both in act and in judgment.

Charms in Medical Practice.—These matters, however, are worthy of consideration to this extent, that a skilled doctor, or any other who has some art to practice, is able to apply symbols and characters (by which is understood fictions) usefully (according to the manner of Constantine, the Physician), not because these characters and symbols are really efficacious in themselves but in order that the medicine may be taken more faithfully and with greater avidity and that the spirit of the patient shall be active and shall later settle and be glad, and that the active spirit shall be able to bring about many renovations in the body which properly appertains to it—so that by gladness and confidence it convalesces from infirmity to health. If therefore a doctor, for the improvement of his work, in order to excite the patient to the hope and confidence of health, does anything of this sort, it is not to be regarded as something which is done because it is efficacious in itself (if we believe Constantine, the Physician) nor to be despised as a fraud.

For Constantine himself in his letter Concerning Charms which are Hung about the Neck concedes symbols and characters to the neck, and defends them for this use. The spirit is powerful mightily over its body through its strong effections, as Avicenna teaches in his book *de Anima* and in that *de Animalibus,* and as all wise men agree. Games and plays are effective against infirmities, and delectable dishes are offered to whatever appetite rejects plain food. Wherefore the mental state triumphs, and desire of spirit is hope over disease. C3.

Species or Idea, or the Extrinsic Quality of Things.— Since truth must not be damaged in any respect, it is necessary diligently to consider how all agents act in their own virtue—not only in their substantial virtue, but through their accidents of the third kind of quality even—and bring their extrinsic idea[3] to bear on Nature; they impart certain sensible properties to things. Thus an object can have an active quality and idea beyond itself, particularly when it is nobler than other corporeal things. Men especially, because of the dignity of the rational soul, drive away spirits by their vital warmth, and similarly they are excited by the proximity of other animals.

We see that certain animals are metamorphosed and that others alter the things which are obedient to them, as for instance, that the Basilisk[4] kills by sight alone, that the wolf makes a man hoarse if he sees him first, and that the hyena does not permit a dog to bark if

he comes within his shadow, according to Solinus in the book *de Mirabilibus mundi*, and according to other authors. Aristotle tells in the book *de Vegetabilibus* that female palm trees mature ripe fruit through the odor of the males; and mares in certain countries are fertilized by the smell of horses, as Solinus narrates. There are many such cases of the effective idea and quality of animals and of plants, many marvels indeed, as is recorded by Aristotle in his *liber Secretorum*. Since plants and animals, which cannot attain to the dignity of human nature, are able to do these things, surely therefore man ought to be able all the more to emit his idea, his virtues, and his colors for the alteration of bodies outside of himself. In this connection Aristotle tells in his book *de Somno et Vigilia* that a menstrous woman looking in a mirror infects it and causes a cloud of blood to appear in it. Solinus further recounts that there are women in Scythia who have twin pupils in the eye (whence Ovid: *Nos quoque pupilla duplex*) and who when they are angry kill men by a glance.

Force of Personality.—We ourselves know that a person of bad complexion who has a contagious infirmity like leprosy, or the falling sickness, or acute fever, or diseased eyes, or some ailment of that sort, infects others who are present and contaminates them; while, on the contrary, healthy persons of good complexion, especially young men, comfort others and delight them by their mere presence. This is because of their soothing

spirit and delectable and salubrious vapors, and because of their good natural warmth, and because of the idea and virtues which they emanate, as Galen teaches in his *Techne*. And those men of infirm body and bad complexions whose souls are corrupted by many and heinous sins can, I strongly believe, accomplish much evil if they have a vehement desire to injure and harm. For, much may be accomplished by the nature of the complexion and by an understanding of the firmness of the soul and by desires. Hence a leprous person who by strong desire and by thought and by vehement solicitude intends to infect some other person who is present may infect him more easily and more strongly than if he had not thought about it nor desired it nor intended it. Truly nature obeys the thoughts and vehement desires of the soul, as Avicenna teaches in the place above cited—and there is no human movement except that which occurs because the natural virtue of the members is obedient to the thoughts and desires of the soul. As Avicenna teaches in the third book *de Metaphysica,* thought is the first mover, thence a desire in conformity to the thought, and later the force of the mind in the members which are obedient to desire and to thought, and this for evil ends, as has been said, and similarly for good purposes. Hence, when a man possesses a good complexion, a healthy body, and youth, and beauty, and elegance of the members, a soul clean from sin, a keen intelligence, and a vehement desire for any undertaking,

then whatever he is able to accomplish by reason of his idea, his courage, his spirit, and his natural heat may necessarily be done more strongly and more vehemently by reason of these several spirits, vapors, and influences than it could be done if any of these forces were lacking. This is especially the case if a strong desire and a valid intention are not wanting. And so, man may bring about great things by word and by deed—provided all the causes which have been described are concurrent.

Efficacy of Words to Help or Harm.—Words arise from the interior of the person by reason of the cogitations and desire of the soul and by reason of the urge and heat of the spirit, and they issue from the vocal organs. The place of their generation is in open passages through which there is a great efflux of such spirits, heat, vapors, virtues,and ideas as are produced by the soul and the heart. So, spiritual effects are produced by words, in so far as, and to the extent that the words are indebted to the power of Nature. We see for example that panting of the breath and yawning and many other manifestations of the spirits and animal heat come from the heart through certain passages. They are generally noxious if they come from a body which is infirm and badly complexioned, while they are comforting and beneficial if they are produced from a clean and healthy body of sound constitution. Similarly then, it is clear that certain natural effects may be brought about by the generation and prolation of words, especially when

the effect is intended and desired. Hence it is properly said that the living voice has great virtue—not because it has that power which magicians ascribe to it, and not because it is efficacious in actually doing or altering anything, but because the living voice is determined by natural causes. One must be exceedingly cautious in this matter; for man errs easily, and many err on both sides, some denying the whole business altogether and some inclining to the magical interpretation.

In short, there are many elegant books which are devoted exclusively to magic, to symbols and characters, incantations, conjurations, sacrifices, and to things of that sort. Such for instance are the books *de Officiis spirituum, de Morte animae,* and *de Arte notoria,* and an infinite number of others which contain none of the power of Art or of Nature but only figments of the Magi. It must however be taken into account that there are many books reputed to be magic which are not such but which contain the dignity of wisdom. Experience will teach which books are suspicious and which not; for if a book treats of the work of Nature or of Art, it is acceptable; if it doesn't, it is to be left as suspicious and unworthy the attention of a wise man. It is the practice of magicians to busy themselves with superfluous and unnecessary things, as Isaac knew when he wrote in his book *de Febribus,* "the rational soul is not impeded in its work unless it is detained by ignorance." And Aristotle says in his *liber Secretorum* that "a healthy

and good man may accomplish anything which is humanly necessary if he is filled with the influence of divine virtue," in that *de Meteoribus* that "there is no power except through God," and at the end of *Ethicorum* that "there is no virtue whether moral or natural without divine and heavenly influence." Hence, when we speak of the power of a particular agent we do not exclude the regimen of the universal agent and first cause, for any first cause has a greater influence on the effect than any second cause, as is set forth in the first proposition of causes. P. C4.

Natural Marvels.—Now that these matters are understood, I shall tell of certain marvels wrought through the agency of Art and of Nature, and will afterwards assign them to their causes and modes. In these there is no magic whatsoever, because, as has been said, all magical power is inferior to these works and incompetent to accomplish them. First, then, of mechanical devices.

Mechanical Devices.—It is possible that great ships and sea-going vessels shall be made which can be guided by one man and will move with greater swiftness than if they were full of oarsmen.

It is possible that a car shall be made which will move with inestimable speed, and the motion will be without the help of any living creature. Such, it is thought, were the *currus falcati* which the ancients used in combat.

It is possible that a device for flying shall be made such that a man sitting in the middle of it and turning a crank shall cause artificial wings to beat the air after the manner of a bird's flight.

Similarly, it is possible to construct a small-sized instrument for elevating and depressing great weights, a device which is most useful in certain exigencies. For a man may ascend and descend, and may deliver himself and his companions from peril of prison, by means of a device of small weight and of a height of three fingers and a breadth of four.

It is possible also easily to make an instrument by which a single man may violently pull a thousand men toward himself in spite of opposition, or other things which are tractable.

It is possible also that devices can be made whereby, without bodily danger, a man may walk on the bottom of the sea or of a river. Alexander used these to observe the secrets of the sea, as Ethicus the astronomer relates.

These devices have been made in antiquity and in our own time, and they are certain. I am acquainted with them explicitly, except with the instrument for flying which I have not seen. And I know no one who has seen it. But I know a wise man who has thought out the artifice. Infinite other such things can be made, as bridges over rivers without columns or supports, and machines, and unheard-of engines. C5.

Optical Phenomena and Devices.—Certain physical figurations[5] are especially marvelous, for mirrors and perspective devices can be so arranged that one appears many, one man an army, and the sun and moon as many as we wish. So, mists and vapors sometimes occur in such manner that two suns, or even three, or two moons, appear simultaneously in the heavens, as Pliny narrates in *2 Nat. Histor.* Since one thing by this means may appear to be many or to be infinite in number, and since it thus actually exceeds its own virtue, then there is no number that is determinate, as Aristotle argues in the chapter *de vacuo.* By this means infinite terror may be cast upon a whole city or upon an army so that it will go entirely to pieces because of the apparent multitude of the stars or of men congregated about it, especially if there be joined to this device another by which perspectives are contrived so that the most distant objects appear near at hand and vice-versa.

We may read the smallest letters at an incredible distance, we may see objects however small they may be, and we may cause the stars to appear wherever we wish. So, it is thought, Julius Cæsar spied into Gaul from the sea shore and by optical devices learned the position and arrangement of the camps and towns of Brittany. Devices may be so contrived that the largest objects appear smallest, that the highest appear low and infamous, and that hidden things appear manifest.

Just as Socrates discovered the hiding-place among the hills of a dragon who was corrupting the city and region roundabout with his breath and pestilential influence, so may all that is going on in a city or in a hostile army be learned from the enemy.

Devices may be built to send forth poisonous and infectious emanations and influences wherever a man may wish. Aristotle taught this to Alexander, so that by casting the poison of the basilisk over the walls of a city which held out against his army he conveyed the poison into the city itself.

Mirrors may be so arranged that a man coming into a house shall really see gold, and silver, and precious stones, and whatever a man desires, but whoever approaches the place will find nothing.

But of sublimer powers is that device by which rays of light are led into any place that we wish and are brought together by refractions and reflections in such fashion that anything is burned which is placed there. And these burning glasses function in both directions, as certain authors teach in their books.

The greatest of all devices, however, and the greatest of all things which have been devised is that in which the heavens are described, according to longitude and latitude, with models which actually go through the diurnal movement. This device is worth more than a kingdom to a wise man.

The foregoing are sufficient as examples of constructed devices, though many other wonders might be mentioned in this connection. P. C6.

Incendiary Compositions.—In addition to these marvels, there are certain others which do not involve particular constructions. We can prepare from saltpeter and other materials an artificial fire[6] which will burn at whatever distance we please. The same may be made from red petroleum and other things, and from amber, and naphtha, and white petroleum, and from similar materials. Pliny reports in his second book that he defended a certain city against the Roman Army, and, by throwing down many incendaries, burned the soldiers in spite of their armor. Greek Fire and many other combustibles are closely akin to these mixtures.

Further: perpetual lamps may be made, and baths which retain their heat forever, for we know of substances which are not burned by fire but which are purified.[7]

Gunpowder.—Beyond these are still other stupendous things in Nature. For the sound of thunder may be artificially produced in the air with greater resulting horror than if it had been produced by natural causes. A moderate amount of proper material, of the size of the thumb, will make a horrible sound and violent corruscation. Such material may be used in a variety of ways, as, for instance, in a case similar to that in which a whole army and city were destroyed by means of the

strategy of Gideon who, with broken jugs and torches, and with fire leaping forth with ineffable thunder, routed the army of the Midianites with three hundred men. These are miracles, if accepted according to their account in size and in substance.

I mention many wonders of another sort, which, though they may have no usefulness, still provide an ineffable spectacle of wisdom and can be applied to inquiring into all those occult matters which the unlearned crowd disbelieve. They are similar to the attraction of iron by the lodestone: for who would believe this attraction unless he should actually see it? There are many wonders of Nature which are not known to the crowd in this attraction of iron, as experience teaches the solicitous inquirer.

But there are still more and still greater than these. For similarly there is an attraction of all metals by the stone of silver and gold. A stone thus runs to vinegar, plants mutually seek one another, and the locally divided parts of animals concur in a natural movement. After I have perceived these things, there is nothing that I find difficult to believe when I reflect that it is either divine or human in its origin.

Self-Activated Working Model of the Heavens—But there are greater than these. The great power of mathematics can build a spherical instrument, like the artifice of Ptolemy in *Almagest*, in which all heavenly bodies are described veraciously as regards longitude and lati-

tude, but to make them move naturally in their diurnal movement is not within the power of mathematics. A faithful and magnificent experimenter might aspire to construct an instrument of such materials and of such an arrangement that it would move naturally in the diurnal motion of the heavens, a thing which seems possible because many things are determined by the movement of the heavens, such as comets, and the tides of the sea, and other things wholly and in part. In the presence of this instrument all other apparatus of the Astrologers, whether the product of wisdom or mere vulgar equipment, would cease to count any more. The treasure of a king would scarcely merit comparison with it.

Alloying of Gold—Other things may be brought about which are not so miraculous as these but which are of great public and private usefulness, as, for instance, that an abundance of gold and silver may be produced in any place one pleases, and this, not according to the possibility of Nature, but according to the complement of Art, for there are seventeen sorts of gold eight of which are prepared by alloying silver with it. The first sorts are made from certain proportions of gold and certain proportions of silver until the twenty-second degree of gold is attained, one degree of gold being increased always by one of silver. Alloying with brass is done in the same manner. And the last sort is twenty-four degree gold without admixture of any other

metal; farther than that[8] Nature cannot go, as experience teaches. Art, however, can augment gold manyfold in degree of purity, and can similarly complete gold without fraud.

More remarkable than the preceding is this, that the rational soul cannot be forced but can be effectively disposed, induced, and excited so that it alters its habits, its affections, and its desires according to the will of another. This may be done not only to a single person but to the entire army of a city or to the people of a countryside, and Aristotle tells of cases of it in his *liber Secretorum,* both for an army, for a region, and for a single person. With these considerations I am nearly at the end of my observations on Nature and on Art. C7.

Prolongation of Life.—The ultimate attainment, in which the whole complement of Art joined with all of the power of Nature is effective, is the prolongation of life for a long time. Many experiences show moreover that this is possible. For Pliny tells of a soldier strong in mind and body who lived in his probity beyond the accustomed age of man, concerning whom, when Octavianus Augustus asked what he did that he lived so long, the enigmatic reply was made that he used oil externally and mulsum[9] internally. Later examples confirm the same opinion. A farmer who was tilling his field plowed up a golden flask filled with noble liquor, and, judging it to be the dew of heaven, he washed his

face and drank with the result that he was renewed in body and spirit and in the goodness of wisdom—and from a ploughman he was made porter to the king of Sicily. This happened in the time of king Ostus. And there is a case attested by the evidence of a papal letter, that Almanicus, while a captive among the Saracens, took a medicine through the effect of which he prolonged his life five hundred years. For the king who held him captive had received this medicine from the ambassadors of the Great King; he was suspicious of it and wished to try it on the captive who was released to him. The Lady of Tormery in England, while searching for a white hind, found an ointment with which the keeper of the woods anointed his whole body except the soles of his feet—and he lived three hundred years without any corruption save pains and suffering in the feet. Many of us are well aware in our own times that farmers living without the advice of medical men frequently attain the age of a hundred and sixty years or thereabouts. The same is also confirmed by the case of animals, like deer, eagles, and serpents, which renew their youth through the virtue of plants and stones. Accordingly, wise men, stimulated by the case of the animals and judging that a thing conceded to brute animals is possible also for man, have devoted themselves to the study of this secret. Because of this, Artephius, who wisely studied the forces of animals,

stones, etc., for the purpose of learning the secrets of Nature, especially the secret of the length of life, gloried in living for one thousand and twenty-five years.

Care of Health.—The possibility of the prolongation of life is confirmed by the consideration that the soul naturally is immortal and capable of not dying. So, after the fall, a man might live for a thousand years; and since that time the length of life has been gradually shortened. Therefore it follows that this shortening is accidental and may be remedied wholly or in part. And if we wish to investigate the accidental cause of this corruption, we shall find that it is not from the heavens nor from anything else except from defects in the care of the health. In our own time fathers are corrupt and for this reason produce children of corrupt complexion and constitution, and the children of these in their turn are corrupted from the same cause; the corruption descends from father to children—and the abbreviation of life increases continuously. But it is not to be inferred that life will continue to be abbreviated forever, for the life of man has been fixed so that in many cases men live three score and ten years and the days thereof are labor and sorrow.

A real remedy against specific corruption might be found if a man from his youth would exercise a complete regulation of his health in all matters pertaining to food and drink, sleep and waking, movement and rest, evacuation, retention, air, and passions of the soul.

For if anyone will observe this regimen from his birth, he will live to the utmost that is permitted by the nature which he has inherited from his parents and will be led to the limit of nature fallen from its original uprightness. Beyond this he cannot go, for the regimen of health is not a remedy for the corruption of our ancient parents. But it is impossible for a man to pursue the temperate middle course which the regimen of health demands, and neither rich man nor pauper, nor wise man, nor fool, nor physicians themselves however perfect they may be, can practice this regimen themselves or cause it to be carried out by others. Nature however is not lacking in necessaries and Art is complete enough; wherefore it is worth while to oppose accidental passions so that they are done away with wholly or in part. In the beginning, when the age of man had just begun, the remedy might have been easy, but now, after six thousand years and more, the remedy is difficult of application.

Wise men, moved by the considerations which have been discussed, have sought to devise means of dealing, not only with the specific defect of the regimen of a particular man, but also with the corruption of our parents, not in expectation of attaining to the years of Adam or Artephius because of the present growing corruption, but that their life might be prolonged a century or more beyond the usual age of men now living. They inquire how far the passions of old age may be retarded

and how they may be mitigated when they cannot be prevented—to the end that life may be prolonged usefully beyond present human estimation. But this always within the ultimate limit; for there is a limit in Nature, imposed upon the first men after the fall from grace, and there is another limit for every particular man which arises from the corruption of his parents. Beyond these two limits it is impossible to pass; one may attain to the limit imposed by his own corruption but not beyond it to the first limit. I believe that a wise man in these present times may attain the one, in as much as it is possible and within the aptitude of human nature, as it was in the case of the first men. This is not to be wondered at, since the aptitude extends itself to immortality, as it was before the fall and as it will be after the resurrection.

If you say that neither Aristotle, nor Plato, nor Hippocrates, nor Galen attained this prolongation of life, I reply to you that neither did they attain the knowledge of many ordinary truths which have later been understood by other students, and were ignorant on many important matters although they labored at them. They occupied themselves too much with other matters and were brought the sooner to old age, consuming their lives in baser common pursuits rather than in puzzling about such important secrets. We know indeed that Aristotle says in *Praedicamentis* that the quadrature of the circle is knowable, though at the time not known,

and, in saying so, confesses himself ignorant along with all others up to his time. But we know nowadays that the truth is known. So Aristotle might have been all the more ignorant of the deeper secrets of Nature. And wise men are now ignorant of many things which the common crowd of students will understand in the future. Hence this objection is vain in every way. P. C8.

The Wisdom of Keeping Secrets.—Now that some few examples of the power of Nature and of Art have been enumerated—in order that we may infer many from few, all from parts, universals from particulars, in order that we may see that it is unnecessary for us to aspire to magic since Nature and Art suffice—I wish to pursue certain singulars in their order and causes and to give their method in particular. But I recall that secrets of Nature are not committed to the skins of goats and of sheep that anyone may understand them, as Socrates and Aristotle have pointed out, and as the latter says in his *liber Secretorum*, "He is a breaker of the heavenly seal who communicates the secrets of Nature and of Art," adding that "Many evils follow the man who reveals secrets." And again in the book *Noctium Atticarum de collatione sapientium*, "It is stupid to offer lettuces to an ass since he is content with his thistles," and in *lib. Lapidum* it is written that "The man who divulges mysteries diminishes the majesty of things, and a secret loses its value if the common crowd knows about it."

The Ignorance of the Vulgar Crowd.—In this discussion[10] distinction ought to be made between the common rabble and the wise who are sharply set off from it. For, whatever is believed by all is true, and similarly whatever is believed by wise men and examined carefully. Therefore beliefs which are held by the many, beliefs which are commonly held by the rabble, must necessarily be false—and I am speaking here of the rabble which is distinguished from the wise in this discussion.

In the common conceptions of the mind the crowd is in accord with the wise, but in the proper principles and conclusions of the arts and sciences it is discordant, and laboring with appearances runs off into sophisms and subtleties which the wise reject altogether. Thus the crowd is in error in its opinions of proper and secret qualities, and so is divided from the wise. Common matters however are of little value in themselves and are not inquired into on their own account but for particular and appropriate reasons.

Seven Ways of Concealing Secrets.—The cause of the obscurity in the writings of all wise men has been that the crowd derides and neglects the secrets of wisdom and knows nothing of the use of these exceedingly important matters. And, if by chance, any magnificent truth falls to its notice, it seizes upon it and abuses it to the manifold disadvantage of persons and of the community. A man is crazy who writes a secret unless

he conceals it from the crowd and leaves it so that it can be understood only by effort of the studious and wise. Accordingly, the life of wise men is conducted after this principle, and secrets of wisdom are hidden by a variety of methods. Some are hidden under characters and symbols, others in enigmatical and figurative expressions, as in the case where Aristotle says in his *liber Secretorum*, "O, Alexander, I wish to show you the greatest of secrets, and it behooves you to conceal this arcanum and to perfect the proposed work of this stone of art which is no stone, which is in every man, and in every place, and in every time, and which is called the goal of all philosophers." Such expressions are found in many books and sciences, and innumerable writings are obscured in this fashion, so that no one may understand them without his teacher.[11] Others hide their secrets in a third manner by their method of writing, as by writing with consonants only like the Hebrews, Chaldeans, Syrians, and Arabians, and as the Greeks do, for there is much among them which is obscured in this way. And there is especially much among the Hebrews, for Aristotle says in the above-mentioned book, "God gave then all wisdom long before they were philosophers, and all nations get their principles of philosophy from the Hebrews," and Albumasar in his book *Introductorii maioris*, and other philosophers, and Josephus in the eighth book *Antiquitatum*, teach the same thing plainly enough. Fourthly,

the obscuring is produced by intermixing various kinds of letters, for so Ethicus the Astronomer hides his wisdom by writing Hebrew, Greek, and Latin letters in the same word. Fifthly, authors hide their secrets by means of special letters, devised by their own ingenuity and will, and different from those which are anywhere in use. This is a most serious impediment, and was used by Artephius in his book *de Secretis naturae.* Sixthly, actual letters are not used but other geomantic figures which function as letters according to the arrangement of points and marks—and this method also Artephius used in his science. Seventhly, there is still a better way of obscuring which is comprehended in the *ars notaria* which is the art of noting and writing with whatever brevity we wish and with whatever rapidity we desire—and by this means many secrets are hidden in the books of the Latins.

I have judged it necessary to touch upon these ways of concealment in order that I may help you as much as I can. Perhaps I shall make use of certain of them because of the magnitude of our secrets. P. C9.

Preparation of the Philosophers' Egg.—I say to you therefore that I wish to set forth in an orderly manner the things which I have narrated above. I wish to describe the egg[12] of the Philosophers and to investigate the parts of Philosophic man, for thereby is an initiation to other things.

I. Grind[13] [*the salt diligently*] with waters and [*purify*] it with other grindings with water, rub it vigorously in various contritions with the salt, and burn it with many blasts [*so that a pure earth shall be made free from other elements*] which I hold worthy for your purpose by the stature of my height. Understand this if you can; for without a doubt there will be a composition from the elements and so there will be a part of the stone which is not a stone, which is in every man and which you will find in its proper place in every season of the year. Then you take oil which is like a salve or a viscous cheese not to be broken asunder by the first thrust. Let its whole fiery virtue be divided, and let it be separated by dissolution. [*Let it then be dissolved in*] acute [*water*] of moderate acuteness [*with gentle heating, and let it be boiled until its scum has separated*] as the scum or fatness of flesh is separated by distillation so that the black virtue in which urine is distilled shall not issue forth to the liquid from its unctuosity. Afterward let it be boiled in vinegar. Then let it be dried among the coals (which is the cause of adustion), and the black virtue may be obtained. But if it is not cured by this treatment, let the process be repeated. Watch and wait.

II. The discourse is difficult at this point. The oil truly dissolves both in acute waters, and in common oil as is done more expressly, and in acute oil of almonds over the fire, with the result that the oil is separated

and the spirit remains hidden both in its animal parts, and in its sulphur, and in its arsenic. For stones in which oil of humidity is in excess have a purpose for their own humors, partly because there is no vehement union when one can be dissolved away from the other on account of the nature of water which is fundamental for liquefaction in the spirit and is the medium between their own parts and the oil. When the solution has been made there will remain to us a pure humidity vehemently mixed in spirit with the dry parts which are moved in it when the fire resolves it. It is sometimes called the *fusile sulphur* of the Philosophers, sometimes oil, sometimes aerial humor, sometimes the conjunctive substance which fire does not separate, and sometimes camphor—and, in short, it is the Philosophers' Egg, or rather the goal and purpose of the egg. And this which comes to us from these oils, but is reputed to be among the sinapica, is separated from the water or the oil in which it is purged.

III. Further, the oil is corrupted as you know by triturating it with desiccating substances such as salt or atrament,[14] and by assation,[15] notwithstanding its passion to the contrary. Then it is sublimed, by which means it is deprived of its oleogineity and becomes like sulphur or arsenic in mineral preparations; and it is good as it is.

IV. It is better that it should be boiled in waters of temperate acuteness [*until it is purged and whiten-*

ed], and the salutary concoction may be in a moist or in a dry fire. [*The distillation is repeated*] in order that it may sufficiently take on the right degree of goodness [*until it is rectified—and the newest signs of the rectification are candor and crystalline serenity*]. When other things are blackened by the fire, this is whitened, and is purified, and shines with serenity and marvelous splendor. [*From this water*]and earth quicksilver is generated, because it is like the quicksilver in minerals. When [*the substance*] has been whitened in this way, it [*is frozen*[16]*—the true aerial stone, which is not a stone, and it is placed in a pyramid in a warm place*], or, if you wish, it is put away in the belly of a horse or ox in acute fever. From this in ten and from that in twenty-one it sometimes results that the feces of the oils are dissolved in their own water; they are afterwards separated, and the solution and distillation are repeated many times until the product is rectified. This is the end of this intention. You know indeed that when you shall have consummated this operation it will behoove you to begin another. P.

V. There is another[17] secret which I wish to conceal for you. Prepare quicksilver by mortifying it with the vapor of tin for pearls and with the vapor of lead for the Iberian stone. Then let it be ground up with desiccating substances like atrament or others which have been named, and let it be digested. Then let it be sublimed, if for union ten times, if for redness twenty-

one times, until the humidity in it is corrupted. It is not possible that its humidity should be separated by vapor like the before-said oil, because it is vehemently mixed with its dry parts, nor does this constitute any object as has been said in the case of the metals above-mentioned. You will not decipher anything in this paragraph unless you understand the proper signification of the words. P.

VI. It is time to involve the third[17] chapter in order that you may understand the key of the work that you seek. A calcined substance also is to be added at some time, and this of such sort that the humor in it is corrupted by salt and sal ammoniac and vinegar, and that it is consumed by quicksilver and is sublimed from it until a powder remains. The keys of the art are therefore congelation, resolution, inceration, and projection, and this is the end and principle. But purification, distillation, separation, sublimation, calcination, and inquisition are also used—and then you may rest. P. Cio.

The Philosophers' Egg Described in Another Way.—*VII.* In the six hundred and second Arabian[18] year you asked me about certain secrets. [*Take then the stone and calcine it*] with gentle assation and with strong contrition, but however without using acute things. [*In the end mix it with a little sweet water and compound a laxative medicine from*] seven things if you wish, or from six, or from five, or from however many you wish. But my mind rests in [*two things the proportions of*

which are in six[19] *or thereabouts better than in some other proportion*], as experiment can teach you. [*Resolve*] the gold [*at the fire*] nevertheless, [*and strain it better*]. If you believe me, take one thing which is the secret of secrets of Nature, able to do miracles. [*Mix it from*] two or from many or from [*the Phoenix*] (which is a singular animal) at the fire *and* [*incorporate with a strong motion. If, to this, the hot liquor be added four or five times, you will have finally the proposed material*]. Afterwards its celestial nature is weakened, if you infuse warm water three or four times. [*Therefore*] divide the weak from the strong in various vessels, if you believe me—and [*let that which is good be emptied out*]. Then bring together the powder and the residual water,[20] and squeeze it out thoroughly—for the unsubstantial water of a certainty will produce a further amount of powder. For this reason, collect the water by itself, for the powder exsiccated from it is suitable to be incorporated in the laxative medicine.

VIII. Proceed therefore as before until you distinguish the strong from the weak. Bring together the powder three or four times, or more; and work always in the same way. And if you are not able to work with warm water, do it by violence. If however it is broken by the acuteness and gentleness of the medicine, add more of the hard and the soft when the powder is at hand. If it is broken by the abundance of the powder, add more of the medicine; if by the strength of the

water, [*stir it with a pestle, bring the material together as well as you can, separate the water little by little*]—and it will return to its state. Dry out this water, for it contains both the powder and the water of the medicine which are to be incorporated in the same manner as the original powder.

IX. Here you must not sleep; for, herein is contained a useful great secret. If you know how properly to make use of certain parts of burned shrubs[21] or of willow or of many other things, they will hold natural union. And do not deliver this secret to oblivion, for it is valuable in many ways. You must mix Trinity with the liquified union and there will arise, as I believe, a thing similar to the Iberian stone, and it must without doubt be mortified by the vapor of lead. You will find lead if you express it from the dead and if you inter the dead in a twig-burning furnace. Keep this secret, for there is nothing of greater usefulness. And you must do these things with the vapor of Pearl and with the stone of Tagus—and you must bury the dead as I have said. P. CII.

The Philosophers' Egg Described in a Third Way.—*X.* In the six hundred and thirtieth Arabian year I respond to your request in this fashion. You must have the medicine which dissolves in that which has been liquified and is anointed by it, which penetrates to the second end of it and is thoroughly mixed with it, and which, since it may not be a fugitive servant, really transmutes

it. Let it combine with the root of the spirit, and let it be fixed by the calx of the metal. It is understood, moreover, that fixion occurs when body and spirit are disposed each in its own place and are sublimed, and everything so happens that body becomes spirit and spirit becomes body.

XI. Take then of the bones of Adam and of the Calx,[22] the same weight of each; and there are six of the Petral Stone and five of the Stone of Union. Let them be ground up together with *aqua vitae* (whose property it is to dissolve all things) until they are dissolved and assated, and the sign of the inceration is that the mixture melts when it is placed upon strongly heated iron. Then it is placed in the same water in a moist place or suspended in the vapor of hot water or some other liquid, and finally it is congealed in the sun.

XII. Afterwards take saltpeter and convert quicksilver into lead. And you will again wash the lead in it, and you will purify it so that it will be near-silver. Then you will operate as formerly. Likewise you will drink all there may be of it.[23]

XIII. However, of saltpeter LVRV VO PO VIR CAN VTRI and of sulphur: and so you will make thunder and lightning, and so you will make the artifice.[24] But you must take note whether I am speaking in an enigma or according to the truth.

XIV. Some men have thought otherwise, for it has been told me that you ought to resolve all to the first

matter. Concerning this you will find that Aristotle speaks in well-known and famous places, and for that reason I am silent about it. When you have this you have many things simple and equal, and you may accomplish it by means of the three contraries[25] and the several operations that I have earlier called the Keys of Art. Aristotle says that "Equality of power confines the action and passion of substances," and Averrhoes affirms the same thing in reproof of Galen. This medicine is thought to be simpler and purer than others which may be found, and it is of value in the treatment of fevers and of passions of the mind and body.

Whoever will rewrite this, will have a key which opens and no man shuts: and when he will shut, no man opens.

ni tuæ reſpondeo in hunc modum: Oportet te habere medicinâ, quæ diſſoluit in liquefacto, & inungatur in eo, & penetret in termino 2. eius, & permiſceatur cum eo, & non ſit ſeruus fugitiuus, & tranſmutet ipſum: radice verò ſpiritus permiſceatur, & per calcem metalli figatur. Æſtimatur autem, quòd fixio præparat, quando corpus & ſpiritus in loco ſuo ponuntur, & ſublimantur: & totiens fiat, vt corpus fiat ſpiritus, & ſpiritus fiat corpus. Accipiatis igitur de oſſibus Adæ, & de calce ſub eodem pondere, & ſunt ſex ad lapidem petralem, & quinque ad lapidem vnionis, & terantur ſimul cum aqua vitæ, cuius proprium eſt diſſoluere omnes res alias, & quod in ea diſſoluatur & aſſetur, & ſignũ incerationis eſt, quòd medicina liqueſcat ſuper ferrum valdè ignitũ: deinde ponatur in eadem aqua loco humido, aut ſuſpendatur in vapore aquarum valdè calidarum, & liquidarum: deinde congeletur ad Solem: demùm accipies ſalem petræ, & argentum viuum conuertes in plumbum, & iterum plumbum eo lauabis, & mundificabis, vt ſit proxima argento: & tunc operare vt priùs. Item potabis totum ſic. Sed tamen ſalis petræ LVRV VO PO VIR CAN vtriet ſulphuris, & ſic facies tonitruum & coruſcationem: ſic facies artificium. videas tamen vtrum loquor in ænigmate, vel ſecundùm veritatẽ. Et aliqui exiſtimauerunt aliter: nam dictum eſt

Page from "Artis Auriferae" showing both the enigmatic and anagramatfic formulas for black powder.

NOTES

The "*Epistola fratris Rogerii Baconis de secretis operibus naturae et de nullitate magiae*" or "*De mirabili potestate artis et naturae*" consists according to Little* of ten or eleven chapters, the last five of which have been considered doubtful ("apparently merely because they are 'enigmatic' "), and was addressed perhaps to William of Auvergne (died 1248) or to "John of London" who has been identified as John of Basingstoke (died 1252). Little enumerates manuscripts in various libraries of Europe, and mentions printed editions as follows—Paris, 1542; Oxford, 1594; Hamburg, 1618; in Zetzner's *Theatrum Chemicum*, 1659; Magnet's *Thesaurus* (1702), I. 616; Brewer in *Rog. Bacon Opera Ined.*, App. I.; French translations, 1557, 1629; English translations, 1597, 1659.

The present translation is made from the *Fratris Rogerii Bachonis Anglici, De Mirabili potestate artis et naturae, Libellus*, printed in the second volume, pp. 494-525, of a collection of alchemical writings entitled *Artis Auriferae quam Chemiam Vocant* (Basileae, 1593, 2nd ed.). As printed in that place it is not divided into chapters. Indeed it consists simply of ten paragraphs, and the division into paragraphs, etc., in the present

*P. 395. Roger Bacon—Essays—Contributed by various writers on the occasion of the commemoration of the seventh centenary of his birth. Collected and edited by A. G. Little, Oxford, 1914.

translation has been determined solely by the sense. As a matter of interest, the paragraphs of the Latin version are indicated in the translation by the paragraph sign (P) printed at the end of each.

The only other edition of this work** which we have seen is the English translation, London, 1659, entitled "Frier Bacon His Discovery of the Miracles of Art, Nature, and Magick Faithfully translated out of Dr. *Dees* own Copy, by *T. M.* and never before in English." In this book the title at the head of the actual translation describes the tract as a letter sent to William of Paris. Little (*loc. cit.*) reports the same in the Hamburg edition of 1618 based on a manuscript of John Dee, but adds that he has not found it in any manuscript. The English translation of 1659 (designated hereafter in these notes by the initials, T. M.) is divided into eleven chapters. These are shown in the present translation by a capital C followed by an Arabic numeral indicating the number of the chapter, thus C7, placed at the point where the several chapters commence. These chapters evidently correspond to the chapters of a manuscript but have no apparent relation to the paragraphs of the Latin of the *Artis Auriferae*. The present translation has been diligently compared throughout with the earlier translation. It differs from it in a number of places, every effort having been made to make it as literal as possible and to include nothing which is not in the Latin.

**Copy in the library of Harvard University.

T. M.'s prefatory address to the reader is as follows—"A Prejudicate eye much lessens the noblenesse of the Subject. *Bacons* name may bring at first an inconvenience to the Book, but Bacon's ingenuity will recompense it ere he be solidly read. This as an Apology is the usher to his other Workes, which may happily breathe a more free Air hereafter, when once the World sees how clear he was, from loving *Negromancy*. 'Twas the *Popes* smoak which made the eyes of that Age so sore, as they could not discern any open hearted and clear headed *soul* from an *heretical Phantasme*. The silly *Fryers* envying his too prying head, by their craft had almost got it off his shoulders. It's dangerous to be wiser than the multitude, for that unruly *Beast* will have every overtopping head to be lopped shorter, lest it plot, ruine, or stop the light, or shadow its extravagancies. How famous this *Frier* is in the judgement of both godly and wise men, I referre you to the Probatums of such men, whose single *Authorities* were of sufficiency to equalize a Jury of others; and as for the Book, I referre it to thy reading. As for my self, *I referre me to him, whom I serve, and hope thou wilt adore.*"

In the notes which follow, the numbers correspond to numbers which are printed in the body of the translation.

1. *Causae vero gramini subditae, et lateribus conditae, ostendunt quod vis humana est et non spiritus.* In the translation of T. M. this reads "which is all easily dis-

covered by private laying hollow canes in the grasse, or secret places, for so the voices of men will be known from other creatures."

2. *Consensus vero omnia fingit quae volunt homines, prout adinvicem disponuntur.* Compare the proverb, "Quand tout le monde a tort, tout le monde a raison."

3. The word *species* is here translated "idea."

4. The Basilisk was supposed by many to be generated from the egg of a cock, whence its other name of Cockatrice, and the supposition had the additional advantage that it explained the scarcity of Basilisks. Since they kill by sight alone, the proper way to hunt one was in an armor of mirrors, that the Basilisk seeing his own reflection might be killed without effort on the part of the hunter. Paracelsus in his treatise "Concerning the Nature of Things," book 1, gives a different account of their generation. "For the basilisk is produced and grows from the chief impurity of a woman, namely, from the menstrual blood. So, too, from the blood of the semen; if it be placed in a glass receptacle and allowed to putrify in horse dung, from that putrefaction a basilisk is produced. But who would be so bold and daring as to wish to produce it, even to take it and at once kill it, unless he had first clothed and protected himself with mirrors? I would persuade no one to do so, and wish to advise everyone to be cautious." (Waite's translation of the *Hermetic and Alchemical Writings of Paracelsus*, 1, 123).

5. *Nam sic possunt figurari perspicua et specula.* In general the word "devices" is used as equivalent to the *figurationes* of this section, whether optical devices are in question or the working model of the heavens constructed to exhibit the movement of the planets.

6. Greek Fire seems to have made its first appearance about 673 A. D., the invention of the Byzantine engineer, Callinicus (Berthelot, *Sur la Force des Matieres Explosives,* II, 355, 3rd ed., Paris, 1883). At that time the Moslem fleet which was besieging Constantinople was destroyed at Cyzica by its use, and for several centuries afterwards it continued to bring victory to the Byzantines in their naval battles with the Moslems and Russians. Emperor Leo, the Philosopher, describes the manner of its use in his *Military Institutions.* The fire was discharged from copper tubes fastened to the prows of the ships. It issued with great rapidity, "with a noise like thunder and burning vapors" and set fire to the ships against which it was directed. Byzantine writers seem to have been intentionally vague on the question of the force which propelled the flame. Whether the expansive force of the gases was used to throw out the burning material is not definitely known. They described also hand-tubes, or *chirosiphons,* designed for use in single combat, for throwing flame into the faces of the enemy. These were undoubtedly filled with a saltpeter composition, for the authors who describe them were

profoundly impressed by the fact that their flame, unlike an ordinary flame, could be directed downward as well as upward.

The Byzantines kept their secret for a long time. It was supposed that an angel had communicated it to the Emperor Constantine, and it was forbidden under pain of the most frightful anathemas to divulge it to the enemy. The Moslems, however, finally learned about it and used it against the Christians at the time of the Fifth Crusade. In the Sixth Crusade the army of Saint Louis in Egypt was assailed with incendiaries thrown from ballistae, with fire from tubes, and with grenades of glass and metal, thrown by hand, which scattered fire on bursting. Joinville in his *Histoire du roy Saint-Loys* (1250 A. D.) writes of this fire that "it came flying through the air like a winged long-tailed dragon, about the thickness of a hogshead, with the report of thunder and the velocity of lightning; and the darkness of the night was dispelled by this deadly illumination." While the Greek fire in this case produced considerable horror, there is no record that any real damage was accomplished.

The Byzantine Greeks kept their secret well. They mentioned specifically many substances which entered into their composition, naphtha, petroleum, sulphur, pitch, etc., indeed all of the incendiaries which had been known to the Ancients, but the prime ingredient, saltpeter, they failed to specify, for that was their secret. The Arabs

however described the mixtures in full, and it is probably from them that Roger Bacon obtained his information about black powder.

In the celebrated book of Marcus Graecus, *Liber ignium ad comburendos hostes* (reprinted in full by Hoefer, *Histoire de la Chimie,* I, 517, 2nd ed., Paris, 1866, and discussed *ibid* I, 304 *et seq.*) Greek fire and other incendiaries are described fully, as is also black powder and its use in rockets and crackers. This work was quoted by the Arabian physician, Mesue, who lived in the ninth century, and was probably written during the eighth.

"Greek fire is made as follows: take pure sulphur, tartar, sarcocolla, pitch, melted saltpeter, petroleum oil, and oil of gum, boil all these together, impregnate tow with the mixture, and the material is ready to be set on fire. This fire cannot be extinguished by urine, or by vinegar, or by sand."

"Flying fire (*ignis volatilis in aere*) may be obtained in the following manner: take one part of colophony, the same of sulphur, and two parts of saltpeter. Dissolve the pulverized mixture in linseed oil, or better in oil of lamium. Finally the mixture is placed in a reed or in a piece of wood which has been hollowed out. When it is set on fire, it will fly in whatever direction one wishes, there to set everything on fire." (Rockets, as here described without sticks, are used in Europe on festival

occasions. They look like Roman candles, and are held in the hand while lighted; then they are liberated and fly, sometimes into the air, but more generally hither and thither among the crowd of merrymakers).

7. "Salamanders skin Talk," T. M. Asbestos.

8. "The last sort is twenty-four degree gold without admixture of any other metal." We still use the same method for indicating the fineness of gold, twenty-four karat being pure gold, eighteen karat being eighteen twenty-fourths gold and the remainder base metal, etc.

9. Mulsum—"now according to the opinion of some, it's eight parts of water, and nine of honey." T. M.

10. This paragraph contains some pretty logic. The premise appears to be, *whatever is believed by the wise is true*. From this it follows that whatever is believed by all is true, for the wise are included among the all and, if the wise didn't believe a thing, then all wouldn't believe it. Yet in the arrangement of his ideas Bacon gives the proposition, whatever is believed by all is true, the position of premise for the deduction of the later proposition which it actually does not imply. The ideas of the Church, because true, must be accepted by all—a dogma which possibly influenced here the order of presentation of Bacon's thought, as earlier in this same tract it undoubtedly influenced him to write that "there are however certain prayers instituted of old by men of truth, especially those ordained to God and to the angels, and others

of that sort, which are able to retain their original virtue," etc. If whatever is believed by the wise is true, then "beliefs which are held by the rabble must necessarily be false" since the rabble is distinguished from the wise in this discussion. Some think that no argument is needed to demonstrate a truth which is obvious to experience, like Nietzsche's Zarathustra, who remarked "If a truth has triumphed in the market-place, verily I wonder what error has fought for it!" But had Bacon dared to point to the obvious in this fashion, he would surely have been called upon to explain what possible errors might conceivably fight for Christian doctrine— and he would have found himself in the absurd position of pointing out errors for the purpose of demonstrating the truth in a connection where no errors were supposed to be. He saves the situation by pointing out that "in the common conceptions of the mind the crowd is in accord with the wise—but in the proper principles and conclusions of the arts and sciences" it is another matter.

11. *Ut memo intelligat sine doctore aliquo,* in order that no one may understand without a *doctor,* (*doceo,* I teach). The degree of *doctor* was given in the early universities of Europe as an endorsement of the doctor's ability to teach. Possibly the Ph. D. degree may still retain something of its old significance. But medical men have so thoroughly prëempted the title that *doctor* now generally has a meaning far from its original one.

12. The Egg was a favorite symbol in all alchemistic writing, for which reason perhaps Bacon chose it as a device under which to conceal his description of the preparation of black powder. Associated with the idea of fecundity, with the egg of Osiris, and with the Egg of the Universe which Khoum put forth from his mouth when he desired to create, the Philosophers' Egg of the alchemists stood especially for the goal of their work, the Philosophers Stone which was the object of their labors, and for the vessel in which the final operation, or consummation, was to be accomplished. This vessel, or Athanor, was shaped like an egg, sometimes of glass hermetically sealed and sometimes of earthenware covered with baked clay; in it the "male and female," the "sulphur and mercury," the pure active principle and the pure passive principle were heated together for months at a time for the preparation of the perfect substance.

13. Lieut.-Colonel H. W. L. Hime (article "Roger Bacon and Gunpowder" p. 321 in the volume edited by Little, *loc. cit.*) proposes the belief that Bacon has concealed his directions for the manufacture of gunpowder by the method of the "Argyle cipher" an example of which Thackeray has given in "Henry Esmond." The key to the cipher consists of a piece of paper or parchment in which holes are cut, the sheet being of the same size as the page of cryptic writing. While the writing as a whole is unintelligible or nonsensical, or conveys an

irrelevant meaning, the part which is visible when the key is applied reads connectedly and conveys the secret. Naturally no key is available in this case, but Colonel Hime has selected the words which he thinks were intended to carry the hidden meaning and finds, when these are read, intervening words being omitted, that Bacon has given a clear and accurate description of the manufacture of black powder.

In the portion of the translation which deals with the preparation of gunpowder the paragraphs are numbered with Roman numerals for easier reference. The English words which correspond to the Latin of Colonel Hime's choice are printed in italics and enclosed within brackets. From their connectedness and intelligibility it is apparent that Colonel Hime's suspicion concerning the nature of the cipher is more than a happy guess. At the same time it is perfectly apparent that his choice is not the only possible choice, words which he has omitted might very well have been intended to be read—for instance, in paragraph IV, Bacon may have intended "until it is purged and whitened, and the salutary concoction may be in a moist or in a dry fire," that is to say, in the water-bath or over a free flame. "The distillation (*i. e.*, solution) is repeated in order that it may sufficiently take on the right degree of goodness until it is rectified," etc.

In paragraphs I, II, III, and IV, Bacon describes the purification of saltpeter by solution in water, boiling until

the scum rises to the top, crystallization, and repeated solution and recrystallization. His use of the expressions "aerial humor" and "*fusile* sulphur" indicates the substance he is talking about. Perhaps he called it the "conjunctive substance which fire does not separate" because of its property of converting many infusible substances into glass or slag. The "stone which is not a stone" is the Philosopher's Stone, the quintessence, the universal substratum of metallic things. When Bacon tells his reader there will be a part of this stone, he laughs in his face; and, when he refers to his substance as "camphor," or "oil," or "viscous cheese," he only adds to the confusion and obscurity.

14. *Atrament*, vitriol. (Pernety, "*Dictionnaire Mytho-Hermetique.*" Paris, 1787).

15. *Assation*, the act of digesting, cooking, subliming, volatilizing, or fixing the material of the work. (Pernety). The word *adustion* of paragraph I is not in Pernety.

16. The saltpeter freezes out of the solution, *i. e.*, crystallizes, and is piled up in a warm place to dry. In the jargon of the alchemists "the belly of a horse or ox in acute fever" is an oven moderately heated. At the end of the same paragraph Bacon suggests the recovery of further material from the mother-liquors, but he speaks of this again more clearly later on.

17. Having described the purification of the saltpeter, Bacon wishes now to speak of the other two substances, charcoal and sulphur, which must be mixed with it for the preparation of the Philosophers' Egg. Paragraph VI evidently refers to sulphur, "a substance of such sort that it is consumed by quicksilver and is sublimed from it until a powder remains"—for sulphur and quicksilver are each volatile by themselves, but, if they are heated together, a portion of the sulphur sublimes away while a portion of it combines with the quicksilver to form mercury sulphide, which remains behind, non-volatile except on vigorous heating. Paragraph V accordingly ought to contain some reference to charcoal, but whatever suggestion it may contain is very effectively concealed. The mention of the facts that the humidity of the substance cannot be separated by vapor and that this constitutes no object anyway may possibly provide a vague clue. In paragraph IX the reference to charcoal is plainer.

18. The Arabians date their calendar from the time of the Hejira or the flight of Mohammed from Mecca to Medina, July 15th, or better, new style, June 20th, 622. Bacon therefore was asked about "certain secrets" in the year 1224 A. D. and he replied (c. f. paragraph X) in the year 1252 A. D. which fixes the date of writing of this tract.

19. The version which Hime used reads *sesquialtera* while that of the *Artis Auriferae* reads *sex*. Hime notes that "Bacon does not name the two substances he alludes to, but Whitehorne (*Certain Waies for the ordering of Souldiers in Battelray*. London, 1560) names two and prescribes the same proportions: 'Two parts of unslacked lime and three of oke asshes.'" These are added to the saltpeter solution to clarify it.

20. The material is crystallized in several fractions, the residue (Phoenix) is leached out, the solution is filtered, and the mother-liquors are evaporated to yield more of the material. This last operation is described twice, clearly, in the closing sentences of paragraphs VII and VIII.

21. Burned shrubs or willow—this is the clearest reference to charcoal. The charcoal of willow, hazelwood or beech is still preferred for the manufacture of black powder. Bacon evidently tells here that the Philosophers' Egg is to be made from certain parts of burned shrubs or willow together with the "stone of Tagus," which is certainly saltpeter, and the "vapor of Pearls" which is perhaps his enigmatic way of indicating sulphur, possibly chosen because of the pearly appearance of a sulphur sublimate.

22. "Of the bones of Adam and of the Calx the same weight of each" evidently means equal parts by weight of charcoal and of sulphur. With the additional

information that six parts of the Petral Stone, saltpeter, are to be taken for every five of the Stone of Union, it is easy to deduce the formula of the mixture—six parts by weight of saltpeter, five of sulphur, and five of charcoal. The materials are ground up together under alcohol and dried in the water-bath and finally in the sun.

23. In the version of the *Artis Auriferae* this sentence reads *Item potabis totum sic,* and is here translated accordingly. In the version which Colonel Hime used it reads *Item pondus totum 30,* and is interpreted by him to signify that there are thirty letters in the completed anagram.

24. *Sed tamen salis petrae* LVRV VO PO VIR CAN VTRIET *sulphuris, et sic facies tonitruum et coruscationen: sic facies artificium.* Hime rearranges the letters of the anagram as follows—

R. VII. PART. V. NOV. CORVL. V. ET

When the anagram is now expanded the passage reads, according to Hime, *Sed tamen salis petrae* [*recipe VII partes, V novelle coruli, V*] *et sulphuris, etc.* The word *et* is properly not a part of the anagram, and there are thirty letters in the expanded anagram here printed between brackets.

Certain writers seem to have had versions in which the anagram was printed LURU MOPE CAN UBRE or LURA NOPE CUM UBRE. When these are rearranged, the letters read *carbonum pulvere.* (Kopp,

Geschichte der Chemie, III, 227. Braunschweig, 1845. Escales, *Schwartzpulver und Sprengsaltpeter,* p. 5, Leipzig, 1914). Since Bacon specifically mentions saltpeter and sulphur, the inference is easy that the anagram signifies *charcoal,* and these versions are probably corrupt—some scribe having tampered with the anagram in order that he might then interpret it more easily. The anagram as interpreted by Hime is certainly the commoner version.

In view of Bacon's own definite statement in paragraph XI (c. f., note 22), I believe that Hime's interpretation is erroneous and think that the letters ought to be rearranged as follows—

R. VI. PART. V. NOV. CORVLI. V. ET

The rectified sentence would then read *Sed tamen salis petrae recipe VI partes, V novi coruli, V et sulphuris, etc.,* and Bacon's formula for gunpowder would be—

Saltpeter	6 parts	37.50 per cent
Young willow (charcoal)	5 parts	31.25 per cent
Sulphur	5 parts	31.25 per cent

This is not a very good formula for gunpowder, but Bacon probably had no knowledge of guns or of the propulsive power of his mixture. The fact that crackers could be made from it seemed to him to be sufficiently wonderful—that "a moderate amount of the size of the thumb" would make "a horrible sound and violent cor-

ruscation"— and there can be no doubt that the mixture which he describes would serve for satisfactory firecrackers.

In his *Opus Tertium* (quoted by Colonel Hime, *Jour. Roy. Artillery*, July, 1911, c. f. Marshall, "*Explosives*," 1, 17. Philadelphia, 1917). Bacon writes—"From the flashing and flaming of certain igneous mixtures and the terror inspired by their noise wonderful consequences ensue. As a simple example may be mentioned the noise and flame generated by the powder, known in divers places, composed of saltpeter, charcoal, and sulphur. When a quantity of the powder no bigger than a man's finger is wrapped up in a piece of parchment and ignited, it explodes with a blinding flash and a stunning noise. If a larger quantity were used, or if the case were made of some solid material, the explosion would of course be much more violent, and the flash and din altogether unbearable."

Marcus Graecus (*loc. cit.*, note 6), probably much earlier than Bacon (8th century), gives a more detailed description of the use of black powder in rockets and firecrackers.

"Take one pound of pure sulphur, two pounds of grapevine or willow charcoal, and six pounds of saltpeter. Grind these three substances in a marble mortar in such manner as to reduce them to a most subtle powder. After

that, the powder in desired quantity is put into an envelope (*tunica*) for flying or for making thunder. Note that the envelope for flying ought to be thin and long, and well-filled with the above-described powder tightly packed, while the envelope for making thunder ought to be short and thick, only half filled with powder, and tightly tied up at both ends with an iron wire. Note that a small hole ought to be made in each envelope for the introduction of the match. The match ought to be thin at both ends, thick in the middle, and filled with the above-described powder. The envelope intended to fly in the air has as many thicknesses (ply, *plicatura*) as one pleases; that for making thunder however has a great many."

Toward the end of the *Liber ignium* he gives a slightly different formula for the powder to be used in rockets.—

"The composition of flying fire is threefold. The first composition may be made from saltpeter, sulphur, and linseed oil. These ground up together, and packed into a reed, and lighted, will make it ascend in the air. Another flying fire may be made from saltpeter, sulphur, and grape-vine or willow charcoal. These materials, mixed and introduced into a papyrus tube, and ignited, will make it fly rapidly. And note, that one ought to take three times as much charcoal as sulphur, and three times as much saltpeter as charcoal."

About 1560 studies were carried on at Bruxelles for the purpose of determining the composition which would give the best effect in guns, and led to the selection of a mixture containing 75.0 per cent saltpeter, 15.62 per cent charcoal, and 9.38 per cent of sulphur. (Molinari e Quartieri, *Notizie sugli Esplodenti in Italia,* p. 90, Milano, 1913).

The first use of black powder for propelling a projectile, that is, the invention of the gun, is frequently ascribed to the monk Berthold Schwartz ("schwartzer Berthold") of Freiburg, but the dates which various writers have assigned to his invention differ widely from one another (1354 to 1393). Moreover, there is no doubt that guns were in actual use before his time. A manuscript in the Asiatic Museum at Petrograd, probably compiled about 1320 by Shems ed Din Mohammed, shows tubes for shooting arrows and balls by means of powder. In the library of Christ Church, Oxford, there is a manuscript entitled *De Officiis Regum,* written by Walter de Millemete in 1325, in which a drawing pictures a man applying a light to the touch-hole of a bottle-shaped gun for firing a dart. On February 11th, 1326, the Republic of Venice ordered iron bullets and metal cannon for the defence of its castles and villages, and in 1338 cannon and powder were provided for the protection of the ports of Harfleur and l'Heure against Edward III. Cannon were used in 1342 by the Moors in the defence of

Algeciras against Alphonso XI of Castile, and in 1346 by the English at the battle of Crecy (Marshall, p. 20, *loc. cit.*).

The following table shows the composition of black powder mixtures which have been used at various times.

		Saltpeter	Charcoal	Sulphur
		%	%	%
1.	Probably 8th Century, Marcus Graecus	66.66	22.22	11.11
2.		69.22	23.07	7.69
3.	1252. Roger Bacon	37.50	31.25	31.25
4.	1350. Arderne (laboratory recipe)	66.6	22.2	11.1
5.	1560. Whitehorne	50.0	33.3	16.6
6.	1560. Bruxelles studies	75.0	15.62	9.38
7.	1635. British Government contract	75.0	12.50	12.50
8.	1781. Bishop Watson	75.0	15.0	10.0
9.	1922. U. S. Army	74.0	15.6	10.4

For nearly four centuries the composition of black powder has changed but little. Improvements have been in the technology of manufacture. Formulas 7 and 8 above are still the standard formulas in many European countries for black powder for military purposes.

In 1846 guncotton was discovered, by Schönbeim at Basle and independently by Böttger at Frankfort-on-Main. In 1865 Major Schultze of the Prussian Army produced the first successful "bulk" smokeless powder. Vielle devised *Poudre B* in 1885, the first colloided, progressive-burning, nitrocellulose powder; and in 1888

Ballistite and Cordite were invented by committees in Italy and in England respectively. Smokeless powder has now entirely displaced black powder as a propellant for military purposes, and has largely displaced it in sporting ammunition. Black powder is still used in pyrotechnics and for fuses and igniters in artillery. For use in the communication of fire or for producing a quick hot flame it is not likely to be superseded.

25. *The Three Contraries*—Knowledge, Power, and Will—*Savoir, Pouvoir,* and *Vouloir.* One may accomplish much with these. From remotest antiquity the three contraries seem to have been one of the deepest of mysteries. The human mind has grasped readily enough the one-two-three notion, the positive term, active, the negative term, passive, each meaningless without the other, and the third neutral inclusive reconciling term which gives unity to the whole. The notion is to be found at the root of all ancient rites and religions. It is at the heart of much of our present knowledge. It was nucleus and center of the knowledge of the Magi. But the three contraries, each essentially meaningless without the other, that is an idea less easily grasped. It was known only to the initiate.

Three contraries, mutually unlike and at the same time each without meaning except in reference to the others: it was and is a mystery. But the fourth term by which these three are reconciled and unified is the mystery of

mysteries, a thing to conjure with. It is the message of the Sphinx.

An old story repeated by a magician of the Middle Ages tells about the initiation of a young Egyptian into the order of the priesthood. Dressed in a special gown for the occasion, suitably washed and perfumed, and after a fast of such duration as to sharpen his wits to their utmost, he was led through a long colonnade consisting of three principal archways. Over the first were the words, "Be Bold." He was stopped and instructed to reflect upon them. Over the second were the words, "Be Bold; Be Bold, and Evermore Be Bold." He was advised to think boldly no matter into what secrets his speculations might lead. Over the third were the words, "Be Bold; But Not Too Bold." He was cautioned that his boldness must be tempered by a wise moderation and intelligent restraint—and in this advice he was given the essential feature of the magical doctrine of the Egyptian priesthood.

When the various qualities of the Sphinx were pointed out to the neophyte, it was usual to enumerate them in a special sequence in order that their lesson might be shaped in a more pointed moral. The man's head symbolizes science, knowledge, intelligence. The eagle's wings symbolize audacity, courage, power, the daring to accomplish. The lion's claws, symbol of will, indicate desire. And the flanks of a bull, symbol of resigned

force, mean silence and restraint. The priest who pointed out these things was accustomed to say to the newly-initiated member of the order, "It is necessary to know in order to dare, to dare in order to want, and it is necessary to be silent in order to have empire."

Among the many curious things which are mentioned so frequently in the writings of the alchemists, reference to the Three Contraries is rare. It may be inferred then that Bacon's statement here is more subtle than the obvious meaning that the Philosophers' Egg may be prepared if one has Knowledge, and Power, and Will, and practices the arts of congelation, calcination, resolution, inceration, and projection. Indeed, with sufficient of Knowledge, of Power, and of Will, anything, *ab hoc,* may be accomplished which is desired and understood. The Three Contraries were known by a few of the most learned only. Bacon's reference to them at the end of his letter is doubtless "Hail and Acclaim:" it is his method of indicating that he is writing to one who is "in on the secret."

dem aquain loco calido & humido, aut ſuſpendatur in vapore aquarum valde calidarum; deinde diſſolvantur, & congelantur ad Solem. Deinde accipias ſalem petræ, & argentum vivum convertes in plumbum, & iterum plumbum eo lavabis & mundificabis ut ſit proxima argento, & tunc operare ut prius. Item pondus totum ſit 30. Sed tamen ſalis petræ LVRV. Vopo Vir Cau Vtriet Sulphuris; & ſic facies tonitrum & coruſcationem, ſi ſcias artificium. Videas tamen utrum loquar in ænigmate vel ſecundum veritatem. Et aliqui exiſtimaverunt aliter. Nam dictum eſt mihi quod debes omnia reſolvere in materiam primam, de qua habebis ab Ariſtotele in locis vulgatis & famoſis: propter quod taceo. Et cum iſtam habueris, tunc habebis pura elementa ſimplicia & æqualia: & hoc facies per res contrarias, & varias operationes, quas prius vocavi claves artis. Et Ariſtoteles dicit, quod æqualitas potentiarum excludit actionem, & paſſionem, & corruptionem. Et hæc dicit Averrhoes, reprobando Galenum. Et hæc exiſtimatur ſimplicior medicina quæ reperiri poteſt, & purior: & quæ valet contra febres, & paſſiones animi, & corporum. Vale. Et quicunque hæc reſeraverit, habebit clavem qui aperit, & nemo claudit: & quum clauſerit, nemo aperit.

Explicuit Epiſtola Baconis de ſecretis naturæ & artis, & de nullitate magica.

[Ad Gulielmum Pariſienſem conſcripta.

Page from "Theatrum Chemicum" showing the black powder anagram and old marginalia attempting its solution.

ADDENDUM

Since the foregoing was prepared for publication, two other versions of Roger's Bacon tract have come to hand. One is the French translation—ROGER BACHON DE L'ADMIRABLE PUISSANCE DE L'ART ET DE NATURE, *où est traicté de la pierre philosophale, traduict de Latin en Francois par Jacques Girard de Tournus*— in *Le Miroir d'Alquimie* of Jean de Mehun, Paris, 1613, pp. 111-176. The other is the *Epistolae Fratris Rogerii Baconis* DE SECRETIS OPERIBUS ARTIS ET NATURAE, ET DE NULLITATE MAGIAE, in the fifth volume of Zetzner's *Theatrum Chemicum,* Argentorati, 1622, pp. 943-962, and is followed by seven pages of notes by John Dee. It is divided into chapters and is evidently identical with the version from which T. M. made his translation and is evidently also the one which was used by Colonel Hime.

I have argued that Hime's interpretation of the black powder anagram is erroneous and have based the argument on the fact that Bacon was not willing to trust his secret solely to the anagram but has also set forth the precise formula of his mixture in the enigmatic passage which reads, "Take then of the bones of Adam and of the Calx the same weight of each," etc. It is interesting to find that these two other versions contain the enigmatic passage *with the same numbers,* and the fact

is of considerable importance if the true formula of Bacon's gunpowder is under consideration.

Qu'on prenne donques des os d'Adam, et de la chaulx soubs mesme poix, six choses ya à la pierre petralle, et cinq à la pierre d'union, et qu'on broye cela avec l'eau de vie, etc.

Accipiatis igitur de ossibus Adae, et de calce sub eodem pondere: et sunt sex ad lapidem Tagi, et quinque ad lapidem unionis, etc. T. M. also has it "the Stone *Tagi,*" plainly saltpeter, the same as the Petral Stone.

In my own copy of the *Theatrum Chemicum,* a previous owner has done much figuring on the page on which the anagram is printed. He seems to have thought that the anagram was constructed according to the system by which the letter *a* stood for one, *b* for two, *c* for three, and so on, the word stood for a number corresponding to the sum of its letters, and its solution was to be found in the word of that ordinal number counting from the beginning of the chapter or from the beginning of some other piece of writing which was to serve as a key. The page is curious and is reproduced herewith.

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